Marine Forces Pacific Experimentation Center

Total Asset Visibility Demonstration After Action Report

Exercise Freedom Banner/Cobra Gold

Thailand

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1. This document describes the Marine Forces Pacific Experimentation Center Total Asset Visibility Experiment conducted during Freedom Banner 02. It reflects our observations, conclusions and recommendations regarding total asset visibility technologies and concepts to support the Marine Corps emerging operational concepts. It does not necessarily represent the formal position of the Marine Corps or the Department of the Navy.

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Executive Summary

A total asset visibility (TAV) experiment was recently conducted in conjunction with Maritime Pre-Positioning Force (MPF) operations during Exercise Cobra Gold/Freedom Banner 2002 in Thailand. The experiment was a Marine Forces Pacific (MFP) Experimentation Center (MEC) Predictive Readiness/Total Asset Visibility Focus Team initiative sponsored by the Office of Naval Research. It was executed by the Third Force Service Support Group (3d FSSG) with technical support from the Naval Facilities Engineering Service Center (NFESC), Science Applications International Corporation (SAIC), and Unisys Corporation. This report discusses the experiment's scope, results, and recommendations.

The experiment was conducted using radio frequency identification (RFID) automatic identification technology (AIT) and two web-enabled automated information systems (AIS). RFID was used in parallel with organic barcode AIT to track the location of 134 Principle End Items (PEIs) offloaded from the MV Williams. During the partial offload at Chuk Samet Port, Thailand, PEIs were tracked through critical points of accountability - Port Operations Group (POG) and Movement Control Center (MCC) located at Chuk Samet Port to the receiving Major Subordinate Element's (MSE) Arrival Assembly Operations Elements (AAOEs) located in Utapao - in support of the Arrival Assembly Operations Group (AAOG), III MEF Command Element, Division and Wing Arrival Assembly Operations Elements (AAOE), and the Blount Island Command (BIC) Tactical Assessment Team (TAT). The RFID data collected was uploaded to the Internet by one of two AIS networks for near-real time visibility by authorized personnel having Internet access.

Introduction

This report discusses the scope, results, and recommendations of a TAV experiment conducted during Exercise Freedom Banner/Cobra Gold 2002. The TAV experiment was a MEC Predictive Readiness/Total Asset Visibility Focus Team initiative sponsored by ONR. The focus team supports MFP initiatives as well as Navy and Marine Corps AIT goals by working with the United States Marine Corps (USMC) AIT Project Office, Headquarters Marine Corps (HQMC) Installations and Logistics (I&L) and the Navy AIT Working Group. The experiment was executed by the Third Force Service Support Group (3d FSSG) with technical support provided by NFESC, SAIC, and Unisys Corporation. This report summarizes five reports written by focus team members discussing different aspects of the experiment.

1. Limited assessment by MFP Center for Naval Analyses (CNA) representative, Jonathan Geithner, assesses potential accuracy, personnel, and time savings in an RFID system compared to the current USMC barcode and AIT systems.
2. After-action memorandum by 3d FSSG Transportation and Embarkation Officer and MEC PR/TAV Focus Team chairperson, Chief Warrant Officer 2 Paul Major, discusses the objectives and outcome of the experiment and includes discussion on AIT supportability within Logistics Automated Information System (LOGAIS).
3. TAV experiment report by NFESC AIT project leader, Daniel McCambridge, discusses the experiment procedure, results, and recommendations and includes specifications on the RFID equipment used in the experiment and network analyses.
4. After-action report by SAIC representatives, Pete James and John Bower, discusses the support SAIC provided and issues related to the use of Iridium terminals.
5. After-action report by Unisys representative, Wendell Moon, discusses changes in the experiment procedure and findings and recommendations for issues encountered during the experiment.

The CNA report can be found in the Appendix, while the remaining reports can be found in the NFESC TAV experiment report (Ref).

Background

TAV is "The capability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment and supplies. It also facilitates the capability to act upon that information to improve overall performance of Department of Defense's (DoD) logistics practices (Ref)."

TAV affects DoD's logistics practices in every situation from overseas conflicts to maintaining equipment at military bases and supply depots in the U.S. and across the globe. A commonly used example of how a lack of TAV affected our operations is Operation Desert Shield/ Desert Storm. Over 40,000 containers were shipped to the Middle East and over half of them had to be opened just to find out their contents and to whom they were supposed to go. So much extra equipment and supplies were shipped that 8,000 containers were never opened and the contents of 250,000 Air Force pallets could not be readily identified (Ref). Simply put, "Way too much time was expended to open shipping containers to discover what was inside them (Ref)." This increased the operation's cost and the number of personnel required not only to receive the extra supplies, but to send them all back.

In Operation Enduring Freedom, while TAV has been improved since Desert Storm with the implementation of new AIS such as Global Transportation Network (GTN) and Joint Total Asset Visibility (JTAV), the data from these systems must still be manually extracted to provide an integrated snapshot useful for command and control (C2) functions such as planning and execution. This manual process leaves room for human error and slows data reporting. As a result, U.S. Central Command, whose area of responsibility includes the Middle East, has officially called for improvements in source data quality and accessibility, in-transit visibility (ITV) of unit and cargo movement, and execution-oriented logistics tools that will bridge the gap between logistics and C2 information systems (Ref).

TAV is implemented by converting information about DoD assets into electronic data that can be collected and manipulated in a shared data environment. The information is gathered by electronic devices, collected in supporting software and considered AIT. While the information gathering process is automatic only to a certain degree depending on the type of technology used, it reduces the labor involved and consequently human error, which increases accuracy, timeliness, and data accessibility. The data collected by AIT is passed to AIS to be viewed and organized into a context meaningful to the user, such as for tracking asset inventories, movement, and maintenance, or for assessing unit readiness and feasibility of operational plans. AIT and AIS are discussed in more detail in the following subsections.

Automatic Identification Technology

AIT is a suite of technologies that enables the automatic capture of source data, thereby enhancing the ability to identify, track, document, and control deploying and redeploying forces, equipment, personnel, and sustainment cargo. AIT can create source data (bar codes for example), collect or capture the data (bar code scanners), pass the data (wireless networks) and allow for the data to be aggregated and viewed at the AIS (Ref). AIT encompasses several data storage media (bar codes, optical memory cards, contact buttons, etc.) that capture asset identification information. The media are interrogated using a variety of means, including contact, laser, and radio frequency (RF) (Ref).

In 1996, the Office of the Secretary of Defense (OSD) convened a joint panel to chart a course for the DoD-wide use of AIT in logistics. As part of this effort, the Deputy Under Secretary of Defense (Logistics), DUSD (L), established the DoD Logistics AIT Task Force. Also in 1996, the Chief of Naval Operations - Director, Supply Programs and Policies Division (N41), directed the Naval Supply Systems Command (NAVSUP) to lead the Navy's effort in AIT. The DoD Logistics Task Force developed a logistics AIT Concept of Operations (CONOPS) that was approved in November 1997. This CONOPS provided a vision for integrating existing and new AIT to support future logistics operations, and emphasized the development of a suite of interoperable AIT media and the infrastructure to support asset visibility and logistics operations across DoD. It became the basis for the DoD Implementation Plan for Logistics AIT dated March 17, 2000 (Ref 6).

In December 2001, USMC Headquarters (HQMC) published the USMC AIT Integration Plan for Installations and Logistics. This integration plan supports HQMC Logistics Campaign Plan, which documents important logistics goals and assigning responsibility to Marine Corps agencies and was updated in FY 2002.

The AIT currently used by the Marine Corps is a linear and 2-D barcode system. Using this system, barcodes are printed, read, and passed to the AIS. Barcodes containing specific item information are printed from a desktop printer or on the spot using a portable printer. A Marine scans the barcode with a portable data terminal (PDT) (see Figure 1). The data can be transferred to a computer for viewing in AIS by cradle or serial cable or by RF communication through a remote access point.

Figure 1. Portable data terminal (PDT) reads linear and two-dimensional barcodes.

The AIT used in this experiment was a radio frequency identification (RFID) system developed for use with SAVI Technologies hardware. SAVI RF 410R tags (Figure 2) were used as the data storage media with Savi interrogators (Figure 3) collecting the RF data for transmission into two different systems, Savi Asset Manager System (SAMS) and TIPS (Unisys developed software approved by DoD for use by the Army). SAMS and TIPS passed on the data to two separate web-enabled AIS: SAMS data went into Asset Viewer / Manager (AVM) and TIPS data went into the United States Forces Korea (USFK) Army ITV server.

Figure 2. Savi 410R 128K RF tag is capable of receiving and transmitting data.

Figure 3. Savi RF wide area interrogator can read tags up to 300 feet away.

Automated Information Systems

AIS allowed the data gathered by the AIT to be aggregated and viewed. Data can be further consolidated into other AIS for joint total asset visibility (JTAV), which is defined as "The capability designed to consolidate source data from a variety of joint and Service automated information systems to provide joint force commanders with visibility over assets in-storage, in-process, and in-transit."

AVM was developed by Alternatives in Leveraged Technologies, Inc. (ALT) under an NFESC contract and ONR sponsorship. AVM is an Oracle relational database that was designed to import tag data, associate it with the Marine Air-Ground Task Force (MAGTF) Deployment Support System II (MDSS II) unit density list (UDL) and deployment data file specifically created for an exercise or operation, and allow users to view and manipulate that data via a web server. The database also generates an export file that can be used to update MDSS II.

The USFK ITV website is run by the Army's Logistics Integration Agency in conjunction with parallel servers in Europe and North America. ITV servers operating with Savi RFID systems are currently set up in several locations in South Korea, Asia, Europe, and North America and are operational on a daily basis in support of non-tactical administrative and operational movements of vehicles, containerized cargo and bulk packaged shipments. This system additionally supports the tracking of all classes of supplies requested from the Defense Logistics Agency (DLA).

Previous Testing

NFESC previously tested the Savi RFID equipment with CSSG-3 in 1999 and 2001 under sponsorship of ONR and the Naval Science Assistance Program. In January 1999, a limited test assessment (LTA) was conducted during Marine Corps Exercise Pacific Impact in Hawaii, which simulated an MPF offload. The RFID technology was tested to assess the benefits of RFID technology in MPF operations. The assessment indicated that AIT could reduce the time required to transfer custody of PEIs to the Military Sealift Command (MSC). In August 2001, NFESC returned to Hawaii to conduct a unit exercise with another simulated MPF offload (Figure 4). The same RFID equipment was used (it was left as a residual from the previous exercise), but this time the data was transferred via organic Marine Corps network to the web-enabled AVM with item specifications extracted from MDSS II.

Figure 4. CSSG-3 Marines setting up RF gate readers in Exercise Pacific Impact.

Exercise Cobra Gold / Freedom Banner 2002 TAV Experiment

Cobra Gold 2002 is a regularly scheduled joint/combined exercise designed to ensure regional peace and strengthen the ability of the Royal Thai Armed Forces to defend Thailand or respond to regional contingencies. The purpose of Cobra Gold 2002 was to improve U.S., Thai, and Singaporean combat readiness and combined-joint interoperability, enhance security relationships, and demonstrate U.S. resolve to support the security and humanitarian interests of friends and allies in the region (Ref 1). Over 14,000 U.S. military and civilian, 7,000 Royal Thai forces, and 80 Singaporean military personnel participated in this year's exercise (Ref 2).

Freedom Banner is the Maritime Pre-Positioning Force (MPF) component executed by III MEF. Equipment was offloaded from two MSC ships from May 3 through May 10, checked through the AAOG at Chuk Samet, and distributed to appropriate AAOEs inland. The offload was conducted in-stream with two ships, MV Lummus and MV Williams, at anchor roughly 3 miles from port. Equipment from the two MPF ships at anchor was craned onto lighters and from the lighters to the pier by the SS Gopher State at the port (Figure 5). Once on the pier, vehicles were received by the Landing Force Support Party (LFSP), processed via POG and MCC to the command, ground combat, air combat, or combat service support elements (CE, GCE, ACE, or CSSE, respectively) AAOEs.

Figure 5. Equipment was unloaded from the SS Gopher State to the pier during Freedom Banner.

The scope of the experiment was to provide 3d FSSG with AIT and to gather data and information about the use of this technology supporting MPF operational environments. Specifically, objectives were to determine/evaluate: viability and validity of RFID/AIT in MPF operations; resource savings in terms of manpower, timeliness, and accuracy in collecting data and providing information to users; concepts for deployment/employment; and other potential uses in the operational and logistical area.

Providing 3d FSSG with RFID meant familiarizing them with the system setup and operation. Experiment team members, Army Unisys Liaison, and 3d FSSG Marines worked together on the setup and operation of the RFID system, which involved attaching RFID tags to 134 vehicles on the MV Williams, associating the tags to the vehicle IDs, and setting up tag readers. In a non-experimental situation, the tags would already be attached and associated to the vehicles. In this experiment, the vehicles were tagged on the MV Williams while off Chuk Samet Port, which involved manually attaching the tags (Figure 6) and recording which tag numbers were associated with which vehicle serial numbers.

Figure 6. 3d FSSG Marine attaching tags to vehicles aboard the MV Williams.

Tripod-mounted tag readers were set up at three sites along the vehicle transit route (Figure 7). The first site was at the AAOG POG where the vehicles entered the port, and the second site was at the AAOG MCC where the vehicles left the port in convoys to the receiving AAOEs. The third site was about 20 minutes away at Utapao where the CE, GCE, and ACE AAOEs were located. Each site had one reader that fed into AVM and one that fed into ITV. Two different types of readers were used: gate readers, which use a motion sensor to detect tags on vehicles driving pass them, and wide area readers, which scan a 300-ft radius at specified intervals. Two gate readers were used by the AVM system and required one person at each site to make sure that the vehicles drove past the motion sensor. The wide area readers, used by both the ITV and AVM systems, could be left unattended.

Figure 7. RF gate reader at Chuk Samet Port.

The AVM and ITV systems were both connected to the Marine Corps Cobra Gold Intranet to provide several types of connectivity. The planned setup was to use the secure Iridium satellite network, but there were problems in supporting the terminals that could not be resolved in time (Ref). Instead, the Intranet was used to connect to the Internet so that the TIPS laptop at the AAOE could transmit data to the ITV server in Korea. The TIPS laptop at the AAOG used a standard analog phone line to connect to the Internet due to slow connectivity through the AAOG LAN. These measures allowed authorized viewers from anywhere that had an Internet connection to view data current within 15 minutes (user defined). ITV subsequently feeds into GTN and JTAV at normal 20-minute intervals so that the data could be viewed in a joint environment. Another use of the Intranet was to send data from the SAMS laptop at the AAOEs in Utapao directly to the AVM laptop at Chuk Samet. Thirdly, TIPS used the Intranet to pass Cobra Gold MDSS II data to ITV, which could not be performed for this exercise using AVM. The dataflow over the intranet for the AVM laptop and two SAMS laptops was monitored by Etherpeek software to measure bandwidth parameters.

Lessons Learned

The second objective of this experiment was to gather data and information about the use of this technology in operational environments. This data and information can help the Marine Corps determine their requirements for RFID or new AIT systems.

1. The data collection process for organic AIT (i.e., barcode systems) was documented and compared with the RFID AIT for timeliness, accuracy, and personnel required (Ref). It was concluded that an RFID system can increase data timeliness to near-real-time visibility, reduce errors due to human recording and data manipulation, and reduce the personnel required for data collection and reporting.
2. Compared to wide area readers, gate readers have an extensive number of components/connections and sensitive power requirements that add to complexity in setup (Ref). A drawback of the wide area reader is the difficulty in determining which tags are currently in interrogator range, and site surveys need to be performed early to determine power, location-specific, and operational factors so that the readers are positioned to capture only what is desired.
3. Overall, TIPS software worked well in writing information to the tags and collecting data to pass to ITV. However, during the experiment we discovered that TIPS could not simultaneously transmit data and operate the tag readers, which is a problem when data transmission rates are slow and tags are not being read while TIPS is updating ITV (Ref). The work-around used in this experiment was to ftp data files less frequently, which was conservatively set at every 15 minutes (vice every few seconds). Compared to the every 2-hour reporting process used with the barcode scanners, this still provided more up-to-date information at the commander's level with less work.
4. Network parameter analysis showed that RFID AIT did not have a significant impact on the network traffic (Ref 1). However, this needs to be tested on a larger scale exercise to determine the effects of significantly more readers and tagged assets.

Recommendations

This experiment has shown that automating the data collection process through RFID technology can significantly improve data accuracy and timeliness while reducing the need for scanning personnel and equipment, as well as personnel responsible for processing the offload data. To expedite the fielding of RFID in the Marine Corps and fully exploit its benefits, the following observations and recommendations are provided:

1. HQMC has published an AIT implementation plan; however, specific requirements for AITs and AIS have not been addressed by the operational forces. For example, in selecting an RFID tag, factors such as physical size, durability, environmental resistance, storage capacity, power, cost, etc. need to be considered. On the other hand, Marine Corps processes should be examined to determine where AIT and AIS have the highest payoffs. Recommend that MFP submit a TAV Universal Needs Statement (UNS) to articulate TAV strategic, operational, and tactical requirements to initiate the process of fielding TAV capability in the Marine Corps.
2. Recent advances in commercial RFID technology have increased the reliability and user-friendliness of the software while reducing tag sizes to less than a credit card that costs about $1 per tag. In addition, the Uniform Code Council and EAN International, the U.S. and European organizations that standardized barcode technology, are in the process of standardizing operating frequencies and communication protocols that will increase interoperability between RFID systems (Ref). This is predicted to make RFID more widespread and drive down costs. Recommend further investigating RFID technology and eventually conducting a USMC-wide experiment that extends from the supply chain to deployment. An experiment on this scale can test how RFID and other AIT can make some logistics practices unnecessary, and eliminate them to increase logistics efficiency.
3. There is no functional LOGAIS Export supporting existing web-based systems (Ref 13). Current ITV networks require standardized Worldwide Port Systems (WPS) data files which LOGAIS cannot accurately export. If RFID technology is to be implemented in the Marine Corps, this will need to be addressed.
4. Although the RFID used in this experiment is not the most current technology, it is military-owned and still has much utility. Recommend re-utilizing the experiment's Savi hardware for a longer period to provide more operational data and observations. 3d FSSG is willing to implement it in support of TC-AIMS for in-transit visibility of 31st Marine Expeditionary Unit (31st MEU) equipment.
5. We were not able to use the Iridium terminals during this experiment due to non-availability of equipment, which resulted in time constraints to properly engineer a solution rather than a technological shortfall. Recommend continuing efforts to integrate the terminals for use in the next experiment.
6. TAV has the potential to not only improve logistics practices but more importantly enhance mission execution.

The location, movement, status, and identity data of units, personnel, equipment and supplies collected by TAV systems can be used with C2 systems to determine unit readiness and aid in mission planning. We recommend integrating AIT with the Common Logistics Command and Control System (CLC2S) as the next step in TAV, which can provide an integrated logistics picture that will result in operational information to be used by commanders in the execution of their mission.

Conclusion

This experiment successfully met the objectives of providing 3d FSSG with RFID and collecting data and information to contribute to Marine Corps TAV requirements. The pairing of the operations and technology communities in this experiment has proven to be the right starting point for implementing TAV across the Marine Corps. To keep our momentum, we need to continue to investigate, test, and assess emerging technologies to improve our tactics, techniques, and procedures.

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Total Asset Visibility Demonstration

Freedom Banner O2

Limited Assessment

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Total Asset Visibility Demonstration

Summary

The MARFORPAC Experimentation Center (MEC) requested that Center for Naval Analysis (CNA) help assess the potential of radio frequency identification (RFID) technology for improving the visibility of equipment during Maritime Prepositioning Force (MPF) offloads. The Marine Corps currently uses bar codes and scanners to track the movement of equipment as it comes off the ships. This is time-consuming, manpower intensive, and often inaccurate. Our assessment is limited to data and observations collected during the demonstration of two RFID systems in Freedom Banner (FB) 02, a partial two-ship offload conducted in support of Exercise Cobra Gold 02.

Approach

We reviewed the methods and systems used by Marines to monitor the equipment flow. We focused on the different agencies involved, the personnel and systems required, how the data were collected and processed, and the timeliness and accuracy of status reports

Two RFID systems were run in parallel with the bar code scanning process on a subset of the equipment offloaded. This enabled us to identify potential advantages offered by RFID in satisfying the information needs of the commander and the arrival and assembly organizations.

Findings

Tracking the offload during FB 02 with bar code scanners required a lot of people and equipment. We estimated that upwards of 63 percent of personnel in the arrival and assembly organizations were involved in some aspect of the tracking process. This excludes Navy personnel and Marines on the ships preparing the gear to be offloaded. There also were multiple collection sites, each requiring a separate set of scanners and laptops.

Collecting and processing the data took an inordinate amount of time. Scan updates were required every two-hours. This data had to be manually processed, scrubbed, and fashioned into reports. Sometimes this required face-to-face meetings between personnel from different arrival and assembly organizations, and/or between the Navy and Marine Corps. Other times the scan data had to be verified against physical inventories.

Using the data to create reports took even more time. We estimated that it took on average 12 hours between the time an item was scanned in at the port and when the data made it into one of the offload status reports. And these reports were not always accurate. One showed equipment as being offloaded one or more days *before or after* it actually had been. Also, no two reports agreed on the total number of items to be offloaded. This resulted in an over- or understatement of the progress of the offload to higher headquarters.

To our knowledge these shortcomings had little affect on the conduct of the offload. But they cast doubt on the system's potential for handling a much larger pier-side evolution running 24 hours a day in conjunction with beach and air operations. This scenario would require far more personnel and scanners to cover day and night shifts and the additional locations. Even with the added personnel we suspect there would be major challenges in keeping up, particularly if the offload sequence and/or distribution of equipment were to change.

In contrast to the bar code scanning process, RFID systems are almost completely automated, require far fewer people to operate, and provide offload data in near real time. While neither system produced a complete set of data, problems encountered either were resolved during the test or are thought to be easily correctable.

Conclusions

A more comprehensive assessment of sensor technology would be based on answers to questions the demonstration could not provide, such as cost and ownership of the system, training, security, bandwidth requirements, and durability, among others.

These issues aside, RFID technology would appear to offer significant advantages over the existing Marine Corps offload management system. Automating the data collection process would eliminate the need for scanning personnel and those responsible for processing the offload data.

Improving the accuracy of the data will reduce uncertainty over what's been offloaded and where it is in the distribution process. This will eliminate the need for lengthy reconciliation efforts.

Having access to the data in near real time will provide greater control over equipment, making it easier to reallocate gear if the commander's priorities change. Allowing this data to be viewed by the commander and his staff could eliminate the need for status reports to higher headquarters.

Based on these objectives, the Marine Forces Pacific (MARFORPAC) Experimentation Center (MEC) in conjunction with the Third Force Service Support Group (3d FSSG) and Naval Facilities Engineering Service Center (NFESC) began a series of initiatives aimed at using sensor technology to achieve TAV. That dialogue resulted in various demonstrations of RFID technology during exercises over the last couple of years and ultimately in the deployment of an RFID system for FB 02.

Of all the services, the Army has made the greatest progress in applying sensor technology to achieve total asset visibility. To learn more about the Army system, 3d FSSG personnel arranged for a UNISYS representative to deploy a similar RFID system for FB 02. The combination of the two RFID systems it was hoped would provide insight into the potential of RFID in helping the Marine Corps achieve TAV.

Introduction

Keeping track of assets and personnel while in transit has long been a challenge for all the military services. One famous lesson from the Gulf War was the need to open over 20,000 containers to see what was inside them.[1] The lack of good

[1] James Miller, *Intransit Visibility: Capturing All of the Source Data*, graduate research paper, School of Logistics and Acquisition Management, Air Education and Training Command, May 1996.

visibility can lengthen the time it takes to generate a combat ready force.

This paper reconstructs select aspects of the Maritime Preposition Force (MPF) offload conducted during *Freedom Banner (FB) 02* in Thailand from 3-10 May 2002. The main focus is on the processes and systems used to track and account for equipment as it was offloaded and distributed. Currently the Marine Corps uses bar code labels and scanners to manage offloads. This is time-consuming, manpower intensive, and often inaccurate. Radio frequency identification (RFID) technology demonstrated during FB 02 may reduce the burden on Marines for tracking gear and improve the timeliness and accuracy of offload data. The purpose of this paper is to examine how RFID technology might offer improvements over bar codes and scanners in managing force closure operations.

Background

The demonstration of RFID technology during FB 02 is the latest in a long line of initiatives within the Marine Corps and throughout DOD for improving the visibility of equipment and personnel as they are moved from one location to another. The Marine Corps' stated goal is *Total Asset Visibility* (TAV), defined as the ability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment, material, and supplies so as to improve the overall performance of logistics practices.[2] TAV is broadly thought to enhance warfighting capability and reduce operating costs.

Based on these objectives, the Marine Forces Pacific (MARFORPAC) Experimentation Center (MEC) in conjunction with the Third Force Service Support Group (3d FSSG) and Naval Facilities Engineering Service Center (NFESC) began a series of initiatives aimed at using sensor technology to achieve TAV. That dialogue resulted in various demonstrations of RFID technology during exercises over the last couple of years and ultimately in the deployment of an RFID system for FB 02.

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Approach

We first outline the exiting systems and processes used by Marines during FB 02 to monitor the flow of equipment from offload points on the pier through the port area and ultimately to the arrival and assembly operations elements (AAOE). We discuss the different agencies involved, the personnel and systems required, how data is collected and processed, and the timeliness and accuracy of the status reports.

Two RFID systems were run in parallel with the bar code scanning process on a subset of the equipment offloaded. This enabled us to identify potential advantages offered by RFID in satisfying the information needs of the commander and the arrival and assembly organizations.

Scope and limitations

This is a quicklook report that relies exclusively on observations and data from a single offload. FB 02 involved the in-stream partial offload of roughly 500 principal end items (PEIs) from two MPF ships. The offload was conducted during daylight hours over an over an eight-day period. As such, the pace and scale of the offload is probably not a good proxy for the simultaneous pierside offload of one or more MPF squadrons and thousands of PEIs that might be expected to occur in a contingency.

The layout of the port and the proximity of the AAOEs to the port may have made it easier to keep track of the offload than might be the case at another facility. For example, the Movement Control Center (MCC) was only a couple of hundred yards from the pier. And the AAOEs were only a twenty-minute drive from the port. Increasing the distance between these locations would complicate tracking efforts. Flowing equipment simultaneously over the beach also would have added complexity.

The vast majority of exercise equipment was brought by sea. In a real contingency the arrival and assembly organizations would also have to manage the arrival of equipment by air. This too would add complexity to the tracking process.

Ideally, we would have liked to compare a mature RFID system with the barcode scanning equipment currently in use. This would have given us truer indicators of the virtues and challenges associated with each. Instead, we focus on the *potential* vice the current suitability of either of the RFID systems demonstrated.

Our assessment of this potential is based solely on its contribution to enhancing in-transit visibility. Having greater visibility presumably could improve many other aspects of Marine operations such as supply support and follow-on sustainment. Sensor technology also could be used to relay data on the condition of an individual piece of equipment. We do not address these broader applications, but they likely will figure in decisions to pursue sensor technology.

Overview of Freedom Banner 02

Freedom Banner is the MPF component to exercise *Cobra Gold*, a combined, joint exercise between military forces from the U.S. and Kingdom of Thailand. The offload was conducted in-stream during daylight hours from 3-10 May with the *MV* Lumus and *MV* Williams at anchor roughly 3 miles from port and the *SS* Gopher State pierside.

Command relations

Various arrival and assembly organizations were established to conduct and manage the offload. CG 3d MEB assigned a portion of the MEB and major subordinate command staffs as the Arrival and Assembly Operations Group (AAOG). The AAOG's main function was to coordinate and control arrival and assembly operations.

[2] United States Marine Corps, *Logistics Campaign Plan*, 2002.

Under the operational control of the AAOG were the Arrival and Assembly Operations Elements (AAOEs). These were established for each major subordinate element (MSE) of the MAGTF as well as the Naval Support Element (NSE). AAOEs received and distributed gear at the unit assembly areas.

Also under the control of the AAOG was the Landing Force Support Party (LFSP). The LFSP controlled the throughput of and distribution of equipment from the port to the AAOEs through two subordinate organizations: the Port Operations Group (POG) and Movement Control Center (MCC). The POG was responsible for preparing the port prior to the arrival of the MPF ships and for the subsequent throughput of equipment as it was offloaded. The MCC formed vehicles into separate MSC convoys for movement to the AAOEs

Commander, Amphibious Group (PHIBRU) Three was designated as Commander, MPF (CMPF). Under the operational control of the CMPF were MPF Squadron (MPSRON) Three, the Naval Support Element (NSE), and the Naval Coastal Warfare (NCW) element. The MPSRON consisted of the MPS ships and personnel. The NSE handled the offload and the ship-to-shore movement. Figure 1 lays out these relationships.[3]

The offload flow

Equipment from the two MPF ships at anchor was craned onto lighters and from the lighters to the pier by the *SS* Gopher State at the port. Once on the pier, POG personnel drove vehicles to the MCC who arranged them by MSE for convoy to the AAOEs at Utaphao Airfield. Vehicles carrying mobile loads were first driven to the disassociated cargo lot prior to entering the MCC. Figure 2 depicts this flow.

Tracking the offload

MAGTF Deployment Support System (MDSS) II served as the principal means for maintaining in-transit visibility during the offload. MDSS II is a database containing information on each piece of equipment on every MPF ship. It is used to build unit density lists (UDLs) and source MAGTF requirements prior to deployment, and to track equipment throughout the deployment and backload.

There are two primary steps to using MDSS II to track offloads. The first is to construct a master file of items to be offloaded and distributed. This was given to each arrival and assembly organization before the offload began. The second step is to scan bar code labels on each piece of equipment, upload this data into MDSS II, and associate the data with the offload file. Bar code labels contain detailed data on each PEI to include unique serial numbers, a description of the item, and dimensional data, among other information.

Equipment was scanned as it entered and exited the OPP and MCC, and upon arrival at the AAOEs. Mobile loaded equipment was recorded as entering the reconciled by the MCMO and MOLO at the end of each day. Transfer of accountability from the MOLO to the BSSG (in the custody of the POG) occurred simultaneously with MCMC-to-MOLO transfer.

Scan data was uploaded every two hours and sent by the LFSP and AAOEs to the AAOG. The AAOG, in turn, used the data to develop various recurring offload status reports. Each scan update overwrote the previous MDSS II file, providing a snapshot vice a moving picture of the offload.

Personnel at each scan site also were directed to maintain logbooks detailing the item ID, serial number, description, and date/time the equipment passed through their area. This was done by some, but normally at a more general level of detail.

Transferring accountability for equipment

MDSS II also served as the primary means for transferring custody of equipment. This was necessary to ensure that items were distributed to the correct location/unit and to

[3] Figures 1 and 2 were supplied by the CNA representative to III MEF.

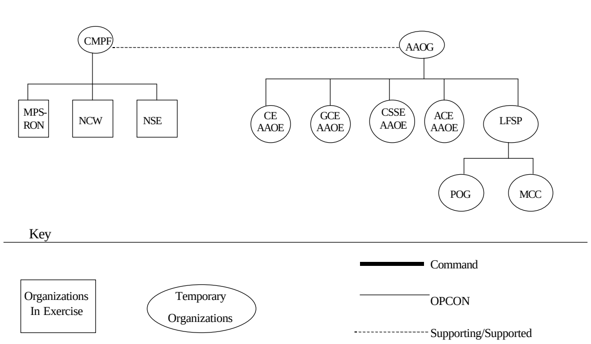


Figure 1. FB 02 command relations

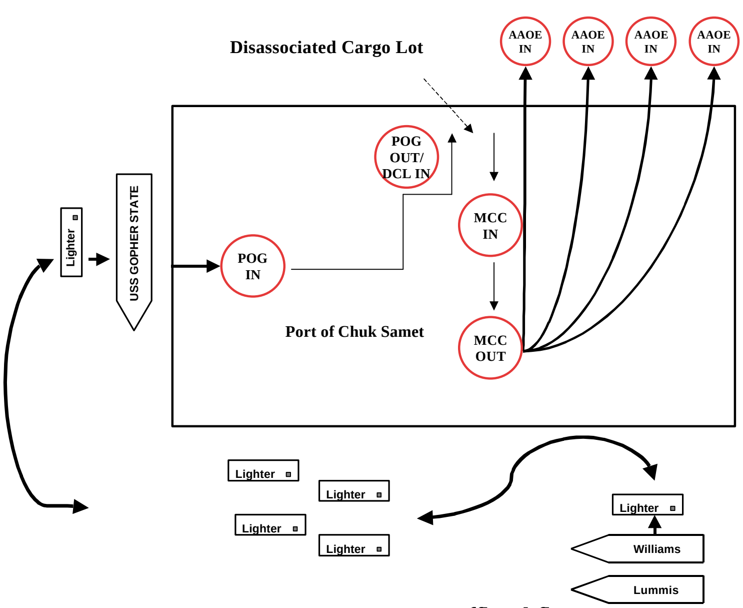


Figure 2. FB02 offload flow

Arrival and assembly organizations	Total Personnel	Personnel involved in tracking/accountablilty	Percent of total
AAOG	38	23	61%
LFSP HQ	11	11	100%
POG	49	39	80%
MCC	7	5	71%
AAOEs (x5)	35	10	29%
Total	**140**	**88**	**63%**

Table 1. FB 02 personnel involved in tracking/distribution/accountability of equipment

facilitate regeneration.

The transfer of accountability of equipment from the Marine Corps Maintenance Officer (MCMO) to the Marine Offload Liaison Officer (MOLO) occurred as equipment was offloaded from the MPF ships. MDSS II scan files served as the interim receipt reflecting items transferred from ship to shore. These were reconciled by the MCMO and MOLO at the end of each day. Transfer of accountability from the MOLO to the BSSG (in the custody of the POG) occurred simultaneously with MCMC-to-MOLO transfer.

Accountability shifted from the BSSG to the unit AAOEs as equipment arrived at the AAOE, again using MDSS II scan data. Equipment was then distributed to each unit where it underwent a limited technical inspection (LTI). Based on the outcome of the LTI, each AAOE completed a consolidated memorandum of receipt (CMR) assigning official custody of the gear to a responsible officer (RO) within the unit. This was to be done using ATLASS software, but most simply e-mailed excel spreadsheets to the AAOG.[4]

Personnel/equipment needed to track the offload

The physical aspects of offloading and distributing equipment are labor-intensive, requiring hundreds of Marines and Navy personnel. Many of these personnel also are involved in tracking/accounting for equipment as it comes off the ships. These personnel include scanners,

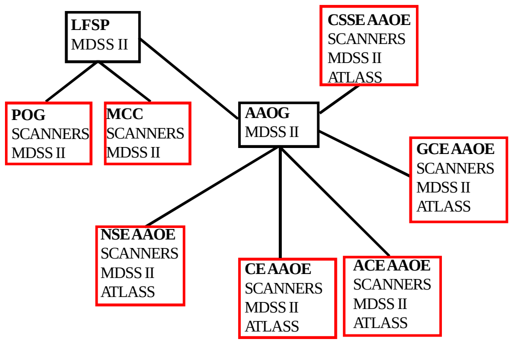


Figure 3. FB 02 AIT locations

MDSS II operators, MSE liaison officers, operations officers, clerks, and others. We examined the tables of organizations (T/Os) of each arrival and assembly organization to determine what percentage of the total was required for these tasks. The results are shown in table 1. We excluded Navy, BIC, OPP, and A/DACG personnel. As such, our estimates represent a lower bound.

Of note is the large number of agencies and personnel involved in the tracking/accountability process. We identified a total of 88 Marines, or 63 percent of the personnel that made up the different arrival and assembly organizations.[5] Appendix A provides a breakdown by billet within each organization.

There are also considerable equipment and software requirements, to include multiple scanning devices, interface/cradle chargers, batteries, laptops with MDSS II/ ATLASS software, printers, tactical phones, cell phones, and radios. Each arrival and assembly organization was responsible for providing and operating its own suite of equipment. Figure 3 shows the different scan locations requiring this equipment.

Collecting and processing scan data

Collecting and processing bar code scan data is a multi-step process. Once the laptops are set up and the scanners are charged, equipment passing through the site is scanned. This scan data is uploaded from the scanner to a floppy disk, imported into the MDSS II database, and processed for rejected records. The clean file is then sorted by location code and formed into a report for the AAOG that includes the item ID number, a brief description of the item, the location code of the scanner, and the item serial number. This report and a backup floppy disk must then be sent to the AAOG. For FB 02, this process was repeated five times a day.

The scanning itself can be difficult. For example, the bar code may be damaged or dirty. Glare from the sun can make it difficult to view the screen to verify that that scanner has successfully read the label. Some Marines wrapped the scanners in plastic to protect them from the rain. This also can interfere with a good scan. The combination of factors can cause delays and/or result in poor data.

Processing the data takes time. MDSS II creates error messages for data it can't reconcile. This may be because the NSN and/or serial number of the PEI don't match records in the database, or because

[5] Numbers for POG may be overstated since some of the Marines serving at the scan sites were receiving training on the use of bar code scanners.

[4] ATLASS stands for "Asset Tracking Logistics and Supply System."

NSN	PKG_ID	Serial Number	NSN Configuration	Item_ID	Description
1080001081173	12:48:41.094		BARE ITEM	C4260	SUPPORT SYSTEM, SCREEN, CAMO
5820014318931	545745		BARE ITEM	A1957	
5820014318931	536048		BARE ITEM		
3830012789909	TRAM-7298		BARE ITEM		
000000TRIWALL	MLMULT10		BARE ITEM		
6115011504140	EZ08887	EZZ08887	SKID MOUNTED	B0730	GENERATOR SET, 3 KW, 60 HZ SKID-MTD
6115011504140	EZ08929	61150111504146	SKID MOUNTED	B0730	GENERATOR SET, 3 KW, 60 HZ SKID-MTD
5895013333040	560736		NOT REDUCIBLE	A1955	RADIO TERMINAL SET

Figure 4. MDSS II Scan data excerpt

the date/time stamp is wrong. These errors have to be manually corrected, sometimes by meeting face-to-face with other arrival and assembly personnel. This further delays the data flow. Figure 4 is a sample of LFSP scan data uploaded into MDSS II before it was scrubbed.

This is only fraction of the problem records we found in the LFSP scan data. The NSN for one of the records appears to be a description of the item. Package ID numbers (2d column) are a mixture of data/time stamps, serial numbers, and item descriptions. Another record has what appears to be an NSN in the serial number column. Each of these discrepancies had to be corrected against the master offload file, increasing the time it took to build offload status reports.

Offload status reports

All of the arrival and assembly organizations maintained status boards and reports to track the offload. Table 2 lists the key reports, the information contained in each, the format in which they were developed, information sources, and the frequency with which they were updated.[6] Many of these reports were printed out in poster-size form and hung throughout the HQs spaces. In other cases information was transferred to white boards for easy viewing.

The reports and the way in which they were created and updated offer some important insights into the tracking and accountability process. Most important is the *lack of automation*. For example, the POG's Offload Tracking Sheet was based on pen/paper logs kept by the Marines scanning vehicles on the pier. These logs were walked over to the POG trailer every two hours and keyed into an Excel spreadsheet. The information was then transcribed onto whiteboards.

AAOG reports also were created manually; first by importing the MDSS II scan data into Excel and then reformatting the data. This too had to be done every two hours. Excel was preferred to MDSS II in

[6] Excluded from this list are reports not related to the tracking or accountability of *equipment* such as morning reports, conference room schedules, Motor T. run rosters, etc.

Agency/Report	Key offload Info	Format/Medium	Data Sources	Updated
POG				
Offload Tracking Sheet	Vehicle type by MSC by ship	Excel	POG IN logs	Every 2 hrs
AAOG				
Offload/Throughput Forecaster	PEIs offloaded/to be offloaded by MSC by day by ship, current location/LTI status	Excel	MDSS II scan updates	Every 2 hrs
Offload/Throughput Status Report (O/TSR) (a.k.a. Transportation Closure Report)	Running total of PEIs received/LTIs complete by MSE as percentage of total/ baseline	Excel	Master MDSSII Database, PAX from FMCC/AACG	Daily (1800)
Master Location Tracker (Offload/ Throughput)	Location of offloaded equipment	Excel	Master MDSSII Database/Excel location reports	Every 2 hrs
CMRs (AAOG consolidates)	PEIs in custody of units	ATLASS, MDSSII Report, or Excel	Master MDSSII Database ("LTI Complete" scan), reconciled w/final MOLO report/physical AAOE inventories	Daily (0800)
AAOG Sitrep	PEIs offload last 24 hrs by MSE (number LTI complete) / running total of all PEIs offloaded as percentage of total/Estimate of PEIs to be offloaded in next 24 hrs	E-mail (Word Doc)	O/TSR, etc.	Daily (1800)

Table 2. FB 02 offload status reports.

Max MDSS II scan lag		Throughput Forcaster Report		
	Lag (hrs)	Date/time of report	Date/tme available	Cum Lag (hrs)
	2:30	5/4/02 15:00	5/5/02 13:13	21:43:00
	2:30	5/5/02 9:00	5/5/02 12:39	6:09:00
	2:30	5/5/02 13:00	5/5/02 17:00	6:30:00
	2:30	5/5/02 15:00	5/5/02 20:34	8:04:00
	2:30	5/5/02 17:00	5/5/02 21:18	6:48:00
	2:30	5/6/02 9:00	5/6/02 20:19	13:49:00
	2:30	5/6/02 17:00	5/7/02 9:30	19:00:00
Average	2:30			12:09:00

Table 3. Time lags in data flow during FB 02

	"Day-offloaded" discrepancies			
	-1 day	**-2 days**	**-3 days**	**+1 day**
PEIs	28	2	2	2

Table 4. "Day-offloaded" discrepancies between the Throughput Forecaster and LFSP scan data.

part because of the ability to create graphs. Occasionally this data had to be verified against physical inventories for accuracy. *The lack of automation delays the flow of information and increases the chances for errors*.

Also evident is that many of the reports were drawn from the same data source, primarily the consolidated scan reports generated every two hours in MDSS II. We would expect the data to agree, but they didn't in all cases. Reports were accessible on the shared drive and/or were posted to a local homepage.

Accuracy and timeliness of the reports

The offload status reports were the key means by which the AAOG kept track of the offload and provided updates to the MEB headquarters. Our analysis focuses on (1) the speed with which data was collected, reconciled, and reported, and (2) the accuracy of the reporting.

Timeliness of reporting

Several aspects of the tracking process created delays in recording the movement of equipment.

- **Update schedules had to be staggered.** The AAOG required the LFSP and AAOEs to submit scan data every two hours (at 0900, 1100, 1300, 1500, and 1700). To meet this deadline the POG and MCC were required to send their scan data to the LFSP one-half hour earlier (i.e., at 0830, 1030, 1230, etc). As such, data on a vehicle passing through the POG IN site at 0831 would not be sent by the LFSP to the AAOG until the 1100 update. This meant that scan data were as much as two-and-a-half hours old by the time they made it to the AAOG.[7]

- **The quality of the data was often poor.** Data uploaded by the LFSP and AAOEs had to be processed for rejected records, sorted into an interim report, and e-mailed to the AAOG. The AAOG then had to consolidate this data with scan data from the AAOE, adding additional time. The lower the quality of the data, the longer the scrubbing process.

- **Reports had to be created manually.** More time was lost building reports: (a) because data has to be exported into excel from MDSS II, and (b) because other data necessary for the report had to be added. For example, the scan data didn't contain the unit to whom the equipment was to be distributed. This was done by manually associating an item recorded by the bar code scanner with the appropriate MSE.

We calculated the average delay (or lag) between the time an item was scanned "POG IN" and when it first appeared on an AAOG offload status report. This helped us identify bottlenecks in the tracking process.

The Throughput Forecaster was the only AAOG report updated every two hours, corresponding to the scan upload schedule. The reports, however, were not available until some hours later as data were associated with MSEs and, when necessary, verified against physical inventories at the AAOEs.

The table 3 shows the time it took for data on a vehicle entering the POG at the start of the two-hour scan window to appear on the Throughput Forecaster. The last row is the average time delay (or lag) in hours. The column labeled "date/time available" indicates when the report was actually completed. This was based on the "last modified" date/time stamp on each file placed on the shared drive. The last column shows the cumulative lag.

The table shows a 12-hour average delay in the data flow. The delays on reports generated on 5 May were more reasonable, but even in these cases the information was three scan-updates old by the time the report was available. [8]

The Throughput Forecaster probably could have been updated more quickly. But it was a new report and it may have been more important to ensure its accuracy than to have it available quickly, at least during this test phase. Or it might not have been a priority given the workload and available personnel.

Report accuracy

We collected MDSS II scan data from the LFSP for every two-hour increment from 3-7 May and compared this data to

[7] Actual lags were not as great in some cases. For example the 0900 scan update at the LFSP was based on the last scan made by the POG IN at 0830. Similarly, the 1700 LFS update to the AAOG was based on POG IN scans occurring up until 1630. What's important, however, is the average lag in data flow during twenty-four hour operations.
[8] To be fair, the longest delays are associated with reports based on scan updates that occurred near or at the end of the workday (i.e., on 4 May at 1500 and on 6 May at 1700). Consequently, the delays reflect considerable dead time associated with non-working hours.

	Total PEIs				
Report	4-May	5-May	6-May	7-May	8-May
Throughput Forecaster	490	495	502	509	
Offload/Throughput Status Report		489	489		
AAOG SITREP			498	503	497

Table 5. Dicrepancies in total PEIs to be offloaded

summary reports generated by the AAOG. These summary reports were important since they formed the basis for daily updates to higher headquarters.

One of these reports, the *Throughput Forecaster*, was developed to give the MSEs a schedule of when they'd get their equipment. The report provided 17 pieces of information (updated every two hours) on all PEIs to be offloaded such as the serial number, item description, day offloaded/to be offloaded, current location, owning MSE, etc. We compared the "day-offloaded" field on the Throughput Forecaster updated on the morning of 7 May to scan data for the first four days of the offload. According to the Throughput Forecaster a total of 243 PEIs had arrived by this time. The results are shown below in Table 4.

We found discrepancies on 34 PEIs, or 14 percent of the total as of 7 May. In 28 cases the Throughput Forecaster showed a PEI arriving a day later than it actually had (column 1). Most of these errors (17) were associated with PEIs offloaded late in the afternoon on 3 May, the first day of the offload. Many of the remaining one-day errors were for PEIs offloaded in the afternoon of 5 May. We know of at least one instance in which LFSP personnel did not send their last scan update for the day to the AAOG until the following morning. This may help explain some of the one-day discrepancies.

In two other cases, the Throughput Forecaster showed a PEI as having been offloaded two days *after* it was scanned in by the POG at the port, and for two PEIs the error was three days. More significant were two cases in which the report indicated a PEI had been offloaded one day *before* it actually had been. To our knowledge these discrepancies had no effect on the conduct of the offload, but they do highlight the challenge of maintaining accurate visibility during the throughput process.

Another inaccuracy we uncovered was the total number of PEIs to be offloaded. This is an important number because it was the only way to show how the offload was progressing. The total changed every day as items were dropped or added. Table 5 shows total PEIs appearing in three different reports. We did not have reports for all days.

The differences are not dramatic, but they show some of the challenges in keeping up with the changes. We'd expect fewer problems in a full offload since the denominator used in calculating "percent offloaded" would not change.

Other tracking challenges

Tracking the flow of equipment within the Marine Corps system was one challenge. Reconciling the Marine offload data with the Navy's record was another. This occurred every day at 1800 after offload operations had shut down. Whereas the Marine's count PEIs, the Navy records "footprint items" (FPIs), and each FPI can equal multiple PEIs. This made it difficult to reach agreement on what had been offloaded and to plan for the equipment scheduled to move the following day.

Were information delays/errors a problem?

This is a difficult question to answer. Most of the data discrepancies were not significant considering the scale of the offload. And while it's true that no one seemed to know how many PEIs were to be come off the ships, the differences in the total were small. They may have resulted in an over- or understatement of the progress of the offload to higher headquarters, but only marginally. And again, in a complete offload the total wouldn't change.

What's more important is what these shortcoming suggest about the "system's" potential for handling a much larger pier-side offload running 24 hours a day in conjunction with beach and air operations. This scenario would require far more personnel and scanners to cover day and night shifts and the additional locations. And even with the added personnel we suspect there would be major challenges in keeping up, particularly if the offload sequence and/or distribution of PEIs were to change.

RFID technology demonstration (FB 02)

Two separate RFID systems were demonstrated during *Freedom Banner* 02, one by NFESC and one by UNISYS. Each system consisted of hardware for capturing the tag data and software for controlling the hardware and collecting and displaying the data. The same RFID tags were used by both systems.

For the purposes of this paper, we do not go into too much detail on the differences between systems. The intent is to identify RFID *potential* vice assess the current suitability of either system.[9] Neither system was used by the arrival and assembly operations organizations to manage the offload.

RFID basics

RFID *tags* are like fancy bar codes. The difference is in the amount of informa-

[9] The Army uses RFID technology all around the world to track movement of equipment and personnel with accuracy rates approaching 100 percent.

[10] For a detailed account of the tag writing, interrogator set-up, and data collection process, see the After Action Review submitted by the UNISYS rep.

tion that can be stored, the ease with which that information can be written to the tag and modified, and hardware/software needed to access and display the information. Tags can be written before or after they are placed on equipment.

RFID *interrogators* are much like bar code scanners, but they don't require people to operate them. There are two types of interrogators: gate readers and wide-area readers. Gate readers are best suited for tracking movement. As such they typically are used along roads or paths traveled by equipment passing from one location to another, such as from the ship at the pier through the POG, MCC, and to the AAOEs. The gate reader interrogates the equipment tags as the equipment passes by.

Wide-area readers have a much longer range and are used to cover a large staging area such as a container operations terminal, frustrated cargo lot, or disassociated cargo lot. Every sweep records equipment within the designated area. This data can then be compared to the previous update to identify items that have entered or departed and what remains.

The RFID demonstration

A total of 134 vehicles on the *MV* Williams were tagged prior to the offload.[10] During the tagging process, Marines noted the vehicle tag and serial number so that data could be written to the tags. This was done using TIPS software. Each tag contained dimensional data, NSN, serial number, and the unit to whom the vehicles were to be distributed, according to information contained in the master offload file. The master offload file was preloaded onto the laptops used by both RFID systems so that the tag data could be properly associated as it was collected. The actual tag writing was done on the ship in about four hours.

Two gate readers were used, one at the POG IN site and one at the AAOE entrance. A wide-area reader was placed at the MCC. In this way tag data could be recorded during each phase of the throughput process. It took roughly three hours to set-up the three sites with approximately five Marines from the POG.

Collecting and processing the tag data

Each RFID system collected and processed the tag data in much the same way. Tag data on vehicles passing by the gate readers (or in the area covered by wide-area reader) were relayed by solar-powered radio frequency links to computers that processed the data. Data collected by the UNISYS system was uploaded to a regional server located in Korea so that it could be viewed on the United States Forces Korea (USFK) In-transit Visibility (ITV) web site. This was done first via the LAN and subsequently by phone line when the LAN got too congested. The web site allows users to run predesignated queries on the data. Uploading the offload data onto the USFK ITV site meant that it was viewable by a much wider audience. Two Iridium Data Terminals were brought to the demonstration to transmit data via satellite, but attempts to use these terminals were not successful. Direct satellite transmission would be useful either as a primary or back-up means to a LAN or phone lines.

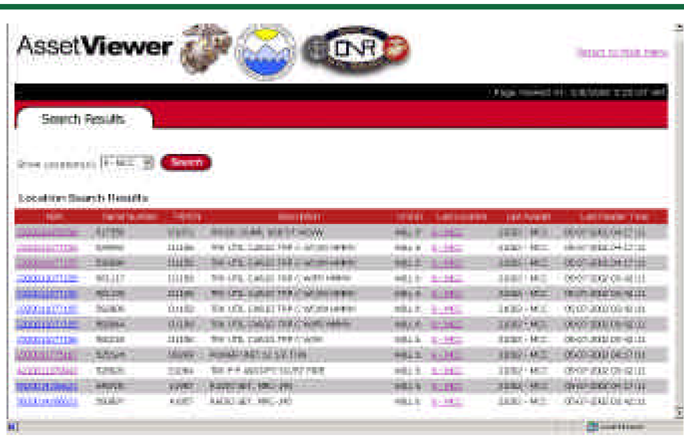
The SAVI Industries system used by NFESC involved two sets of laptops. One set was used to receive the tag data from the interrogators and send it via file transfer protocol (FTP) to a second set of laptops equipped with software to process and manipulate the data. These laptops were preloaded with the master offload file allowing the computer to correctly associate the tag data as it was collected. The software for viewing the data also was able to export the data to MDSS II so that it could be updated with the information collected from the tags.

Once the equipment was set-up, personnel needed only monitor the data transmissions. With the exception of these individuals (one UNISYS and four NFESC reps) and a single Marine stationed at the POG IN gate reader to direct vehicles, no additional presence or action was required.

The *frequency* with which tag data was collected, transmitted, and uploaded also varied. Data captured by the UNISYS system was uploaded to the USFK server every 15 minutes so as to limit the size of the files. These files typically took as few as twenty seconds to upload using a modem. NFESC's SAVI system was set-up to transmit new data every five minutes. This contrasts sharply with the *two-hour intervals* established for the bar code scan updates. More significant, however, is that the data was automatically associated with the offload plan and almost instantly updated. The data could then be sorted and displayed in a variety of ways in *near real time*. *Allowing this data to be viewed by the MEB commander would eliminate the need for status reports.*

Displaying the data

Theoretically, data can be displayed in any manner desired by the user. The queries available through AVM allowed the user to sort by location, serial number, TAMN, MSE, etc. Below are two snapshots



taken from AVM. The first shows all PEIs at the MCC.

The offload status reports maintained by the AAOG all focused on the number of PEIs received by each MSE compared to the total expected. This data had to be extracted from the MDSS II scan updates, a process that took hours in some cases. The screen shot below shows how AVM was able to convert the tag data into a stop light chart with the same information almost immediately and at any point in the offload.

RFID data issues

Several problems were encountered collecting the RFID tag data resulting in processing delays and/or an incomplete/inaccurate data set. Some of the problems were resolved quickly; others will have to be fixed before the next demonstration. When all the data was tallied, the UNISYS system recorded more vehicles leaving the port and entering the AAOE than had arrived at the port. In contrast, the NFESC data showed only a subset of vehicles recorded at the port as having arrived at the AAOE. We know that the vast majority of tagged vehicles made it to the AAOE.

One of the problems involved loss of power to the interrogator at the AAOE sites. Data could not be collected during the time the generator was down and we do not know how many vehicles were missed because of this.

Tags on vehicles that made it to the AAOE were removed and turned off. The AVM software used by the NFESC interpreted this to mean the vehicles had never left the ship, creating inaccuracies in the database.

The TIPS software used by the UNISYS rep was not able to simultaneously collect data and upload it to the server. This was only a problem when the laptop was connected to the LAN, which was very slow at times. The problem was corrected by connecting the laptop to a modem, but not before some vehicles were missed.

Conclusions

A more comprehensive assessment of sensor technology would be based on answers to questions the demonstration could not provide. For example, how much would sensors and interrogators cost? Who would own and maintain them? What training would be required? How much bandwidth would they consume? How durable would they have to be?

These issues aside, RFID technology would appear to offer significant advantages over the existing Marine Corps offload management system. Automating the data collection process would eliminate the need for scanning personnel and equipment, as well as those personnel responsible for processing the offload data.

Improving the accuracy of the data will reduce uncertainty over what’s been offloaded and where it is in the distribution process. This will eliminate the need for lengthy reconciliation efforts.

Having access to the data in near real time will provide greater positive control over equipment, making it easier to reallocate gear if the commander’s priorities change. Allowing this data to be viewed by the commander and his staff will eliminate the need for status reports.

Appendix A: CNA Assment Report

This appendix contains a list of individuals in the AAOG, LFSP HQ, POG, MCC, and each AAOE involved in some way with the tracking, distribution, and accountability of equipment as it was offloaded during FB 02. We do not include Navy, BIC, or POG personnel. Data on personnel for the AAOEs is notional. There were five AAOEs (CE, GCE, ACE, CSSE, and NSE), each with roughly 7 personnel, or 35 for all AAOEs. Of this total, we estimated a total of 10 Marines (two per AAOE) were needed to scan equipment and create CMRs.

Org Sub Total	Arrival/ Assembly Org	Billet	Assignment	Tracker	Total Trackers	Org Total	% Org Total
1	**AAOG**	OIC		1			
2		INTEL OFFICER					
3		INTEL CLERK					
4		COUNTER INTEL OFF					
5		LANDWARD SEC OFF					
6		FORCE PROT OFF					
7		OPERATIONS OFFICER		1			
8		ASST OPS OFFICER		1			
9		AAOG CHIEF		1			
10		ASST AAOG/LOGAIS CHIEF		1			
11		MDSS OPER		1			
12		SUPPLY OFFICER		1			
13		SUPPLY CLERK		1			
14		CE LNO		1			
15		GCE LNO		1			
16		ACE LNO		1			
17		CSSE LNO		1			
18		LOG OFFICER		1			
19		LOGISTICS CHIEF		1			
20		CLERK/DRIVER G4					
21		ADMIN CHIEF		1			
22		STRATEGIC MOBILITY OFFICER		1			
23		EMBARK NCO		1			
24		TRANS COORD		1			
25		ROADMASTER					
26		ROADMASTER					
27		COMM OFFICER		1			
28		RADIO OPER		1			
29		RADIO OPER		1			
30		DATA SYS OP		1			
31		DATASYS OP		1			
36		PAO					
37		PA CHIEF					
38		PROTOCOL CHIEF			23	38	61%
1	**LFSP HQ**	LFSP CO		1			
2		LFSPXO/OPS OFF		1			
3		LFSP 1STSGT		1			
4		LANDING SUPPORT CHIEF		1			
5		LFSP OPS CHIEF		1			
6		LFSP LOG OFFICER		1			
7		LFSP LOG CHIEF		1			
8		LOGAIS NCO		1			
9		EMBARKER/LOGIAS NCO		1			
10		LOGIAS CLERK		1			
11		LOGIAS CLERK		1	11	11	100%
1	**MCC**	MCC OPS OFF		1			
2		MCC CHIEF		1			
3		MCC ASST. CHIEF		1			
4		LOGIAS REP		1			
5		LOGIAS REP		1			
6		MT OPR					
7		MTOPR			5	7	71%

Org Sub Total	Arrival/ Assembly Org	Billet	Assignment	Tracker	Total Trackers	Org Total	% Org Total
1	**POG**	POG OIC	POG HQ	1			
2		POG SNCOIC	POG HQ	1			
3		POG CHIEF	POG HQ	1			
4		LS TEAM LEADER	COT LOT	1			
5		LS TEAM LEADER	DCL	1			
6		LS SPECIALIST	DCL	1			
7		LS SPECIALIST	DCL	1			
8		LS SPECIALIST	DCL	1			
9		LS SPECIALIST	DCL	1			
10		LS SPECIALIST	DCL	1			
11		LS SPECIALIST	DCL	1			
12		LS SPECIALIST	DCL	1			
13		LS SPECIALIST	DCL	1			
14		LS SPECIALIST	DCL	1			
15		LS SPECIALIST	DCL	1			
16		LS SPECIALIST	MCC	1			
17		LS SPECIALIST	MCC	1			
18		LS SPECIALIST	MHE	1			
19		LS SPECIALIST	MHE	1			
20		LS SPECIALIST	MHE	1			
21		LS SPECIALIST	POG HQ	1			
22		LS SPECIALIST	POG IN	1			
23		LS SPECIALIST	POG IN	1			
24		LS SPECIALIST	POG IN	1			
25		LS SPECIALIST	POG IN	1			
26		LS SPECIALIST	POG IN	1			
27		LS SPECIALIST	POG IN	1			
28		LS SPECIALIST	POG IN	1			
29		LS SPECIALIST	POG IN	1			
30		LS SPECIALIST	POG IN	1			
31		LS SPECIALIST	POG IN	1			
32		LS SPECIALIST	POG IN	1			
33		LS SPECIALIST	POG OUT	1			
34		LS SPECIALIST	POG OUT	1			
35		LS SPECIALIST	POG OUT A	1			
36		LS SPECIALIST	POG OUT A	1			
37		LS SPECIALIST	POG OUT A	1			
38		LS SPECIALIST	POG OUT A	1			
39		LS SPECIALIST	POG OUT B	1			
40		LS SPECIALIST	n/a				
41		LS SPECIALIST	Medical				
42		LS SPECIALIST	Medical				
43		LS SPECIALIST	n/a				
44		LS SPECIALIST	Medical				
45		LS SPECIALIST	Duty Recovery				
46		LS SPECIALIST	Beach Detail				
47		LS SPECIALIST	Beach Detail				
48		LS SPECIALIST	Duty Recovery				
49		LS SPECIALIST	Beach Detail		39	49	80%
1	**NATIONAL AAOE x5**	ASST HQ COMMANDANT		1			
2		EMBARK NCO		1			
3		SUPPLY CLERK					
4		MT OPERATOR					
5		MT OPERATOR					
6		AUTO MECH					
7		GENERATOR REPAIRMAN			10	35	29 %
Totals					**88**	**140**	**63** %

MARINE FORCES PACIFIC

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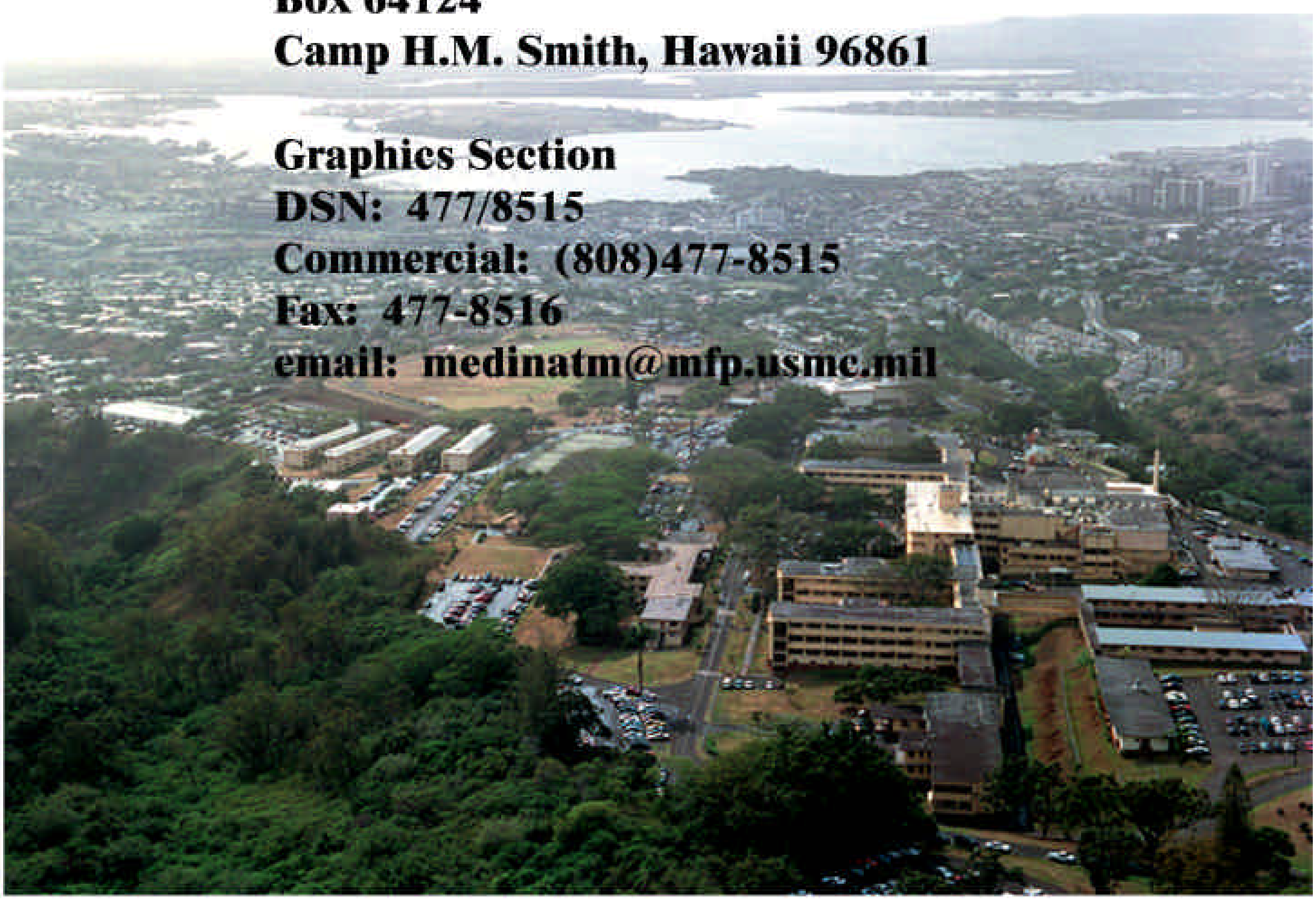

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